Aircraft Design
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Lecture - 44
Numerical - Estimation of Weight Fraction

Hello friends, I am Sarvesh Onkar Ta for this course aircraft design, today I will discuss about the problem of weight fraction. In this problem we have an civilian aircraft with velocity 0.6 mach number and aircraft carrying total equipment and payload 10,000 pounds and 4 crew number of 800 pound.

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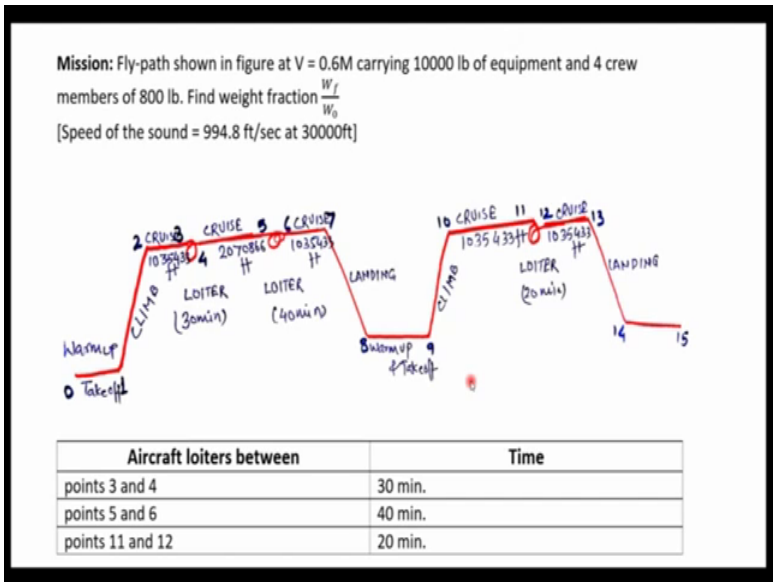

Aircraft loiters between	Time
points 3 and 4	30 min.
points 5 and 6	40 min.
points 11 and 12	20 min.

We have to calculate weight fraction Wf by W naught and for this calculation the speed of sound is 994.8 feet per second. As soon in the figure this is your mission profile aircraft loiter between point 3 and 4 for 30 minutes and point 5 and 6 for 40 minutes and point 11and 12 for 20 minutes. So, same problem only mission profile has been changed in this example.

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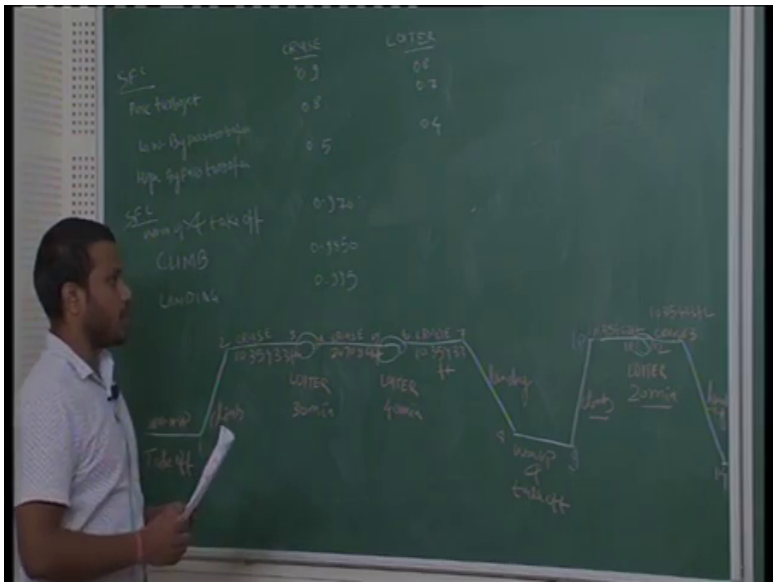

So, first I will read the data for this of the different types of engines. So, here the SFC for pure turbojet, for low bypass turbofan high bypass turbofan for cruise, for loiter 0.9, 0.8, 0.8, 0.7, 0.5, 0.4 and SFC for different weight fraction. So, me mop and take off climb and landing. So, from me mop and take off 0.970 0.995, and the mission is loiter again loiter. So, for this mission this one is warm up and take off climb and this is cruise range of this is 0.3 that is in feet and there is a loiter.

Loiter for 30 minutes, suppose I am taking 30 minutes again the range of this cruise that is 20708 double 6 feet. Again loiter for 40 minutes 0.5 and 6 as cruise at the same range 10354 double 3 feet and here suppose there is a emergency landing. So, here again we will take warm up and take off, and this is a landing 0.8 0.9 and 10, again climb and cruise at 10354 double 3 feet, and loiter is 0.10 and 11, 12, 13, 14. So, here again cruise at same range that is 10354 double 3 feet and this is landing 10, 9.

So, now we our this is a different type of mission, and we will start the calculation of weight fraction between difference points.

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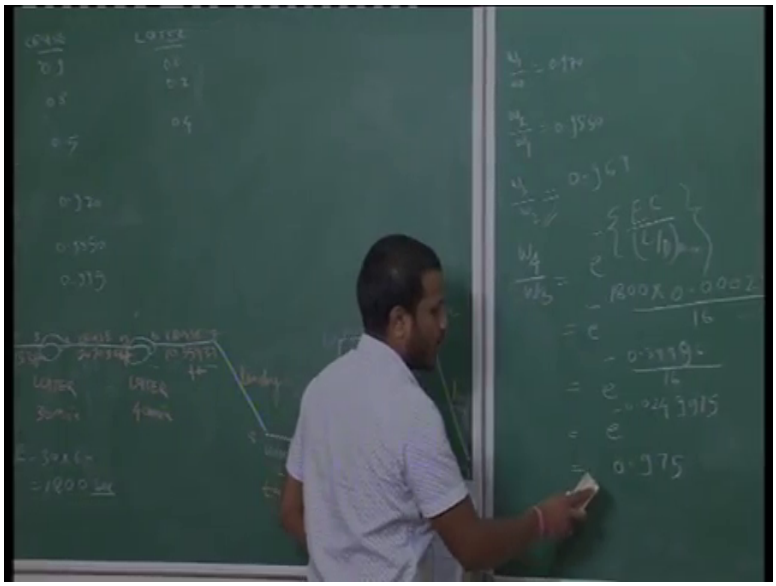

So, first we will use the historical data. So, w one by w naught is warm up and take off that is 0.970, second for the climb w 2 w one that is 0.985, third one is w 3 by w 2. So, this is cruise. So, in this require in this mission our aircraft is same as the previous one is pure turbojet engine. So, for cruise condition the we will use the historical data that is 0.9. So, first we will convert into second.

So, that is 0.000 per second. So, for cruise condition Rc V into L by D max L by D not max. So, put the value of R that is range, 10354 double 3 feet into this value C SFC specific fuel consumption into velocity 596.88 into 13.9l by d 0.886. 0.886 into L by D max as a previous one the L by D max range is 16. So, that is 13.9.

Basically the range of L by D is between the 16 to 20. So, here for this problem I am taking 16. So, L by D is 13.9. So, that is e raised to the power 258.85825 divided by 80 to 96 632 please check it, and the w 3 by w 2 is 0.969. So, w three by w 2 is 0.969. Again we need to find the ratio of w 4 by w 3, the weight fraction of w 4 by w 3 that is in loiter case. So, for loiter Ec divided by L by D max. So, that is e. So, for e you need to convert into second 30 into 60 1800 second. So, put 80 1800 into c for pure turbojet engine, the loiter in loiter case the c is 0.8. So, we need to convert it 0.8 that is in per hour.

So, 0.8 about three 1600 and this will give the 002222 per second. So, put here 0.222 divided by the L by D max value is 16. So, here e to the power minus 0.399 x divided by

16. So, value is e to the power minus please check the calculation 9975. So, value is 0.975. So, w 4 by w 3 is 0.96, 0.975.

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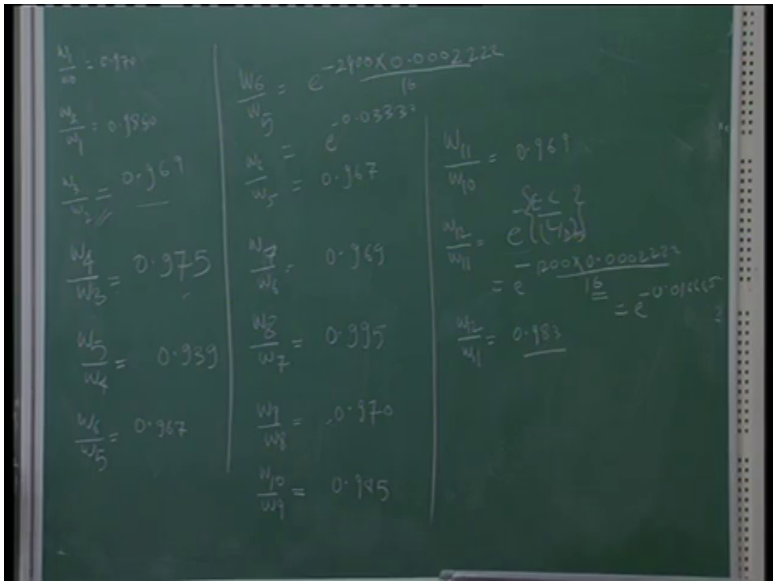

So, I will erase it and. So, weight fraction between 0.5 to 0.4 again same as cruise and same formula we will use that is Rc divided by V into L by D, that is e raised to the power R is 20708 double 6 into c 0.00025 divided by 596.88 into 13.9.

This is e to the power 0.0010624 that is 0.939. So, w 5 by w 4 is 0.939. So, 0.939. So, again 4.5 to 6 the weight fraction between 0.5 to 6 is loiter for 40 minutes. So, e for this case this is supposes e 1. So, 40 minutes into 60, 2 4 double 0.000222 divided by L by D max 16. So, again w 6 by w 5 is e to the power minus 0.03333 that is 0.967. So, I will right here point w 6 by w 5 is 0.967. So, again for this cruise condition this range and this range is same. So, ratio is also same. So, ratio will be w 5 by w 6.

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Sorry w 7 by w 6 is 0.969 and for 0.7 to 8. So, w 8 by w 7 for landing we will use the historical data that is 0.995. So, that is 0.995 again here I am taking this condition warm up and take off. So, using historical data w 9 by w 8 for warm up and take off 970, and for again 0.9 to 10 that is climb. So, for climb is 0.985. So, here for 0.10 to 11 their n range is same as 0.2 to 3 and 0.6 to 7. So, weight ratio weight fraction will be same.

So, here w 11 by w 10 same as w 3 by w 2 or w 11 by w 6; so w 7 by w 6 is what? 9 6 9 again the loiter; so w 12 by w 11. So, loiter for 20 minutes. So, again we have to convert it E2 20 into 60 that is 12 double 0 second. So, for loiter EC divided by L by D. So, e to the power e is 12 double 0 second 1200 second in to c for the loiter case, 02222 the L by D value. So, this is max value. So, l by g max value is 16. So, w 12 by w 1 is 0.983 please check this value. So, this will be e to the power minus 0.016665. So, it will 0.8 0.983.

So, again for 0.12 to 13; so w 13 by w 12, again range is same as you see 10354 double 3 is equal to the and this path value and this path value also. So, weight fraction will be also same. So, it will be 0.969 and again use the historical data. So, here historical data is for landing 0.995. So,14 divided by 13, 0.995 we need to find the w f by w naught. So, w f is equal to final weight is equal to initial minus final that is 14.

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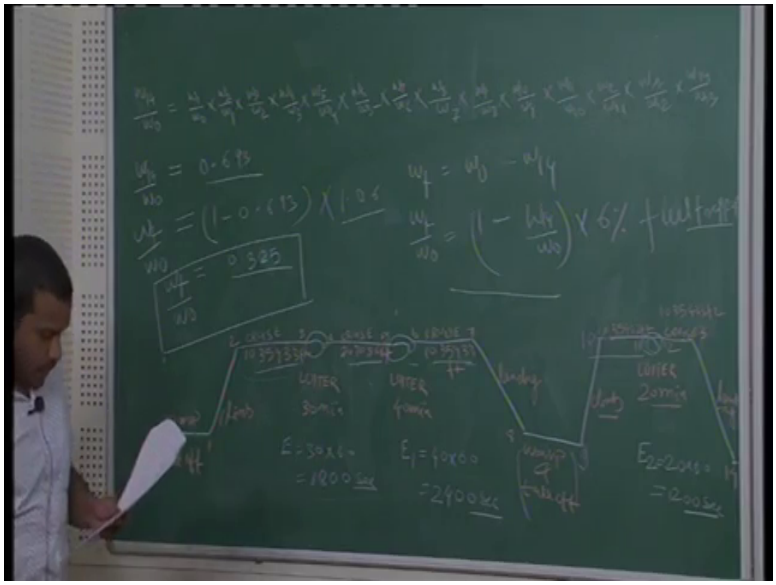

So, w f by w naught is one by w 14 by w naught into 6 percent fuel trapped. So, find the value of w 14 by w naught. So, w 14 by w naught is equal to w 1 by w naught into w 2 by w 1 into, w 3 by w 2, into w 4 by w 3, into w 5 by w 4, w 6 by w 5, w 7 by w 6.

w 8 by w 7, w 9 by w 8, w 10 by w 9, w 11 by w 10, w 12 by w 11, w 13 by w 12, w 14 by w 13, put all the weight fraction into this equation and find the value of w 14 by w naught. So, value is corresponding this weight fraction this is a equal to [FL] and again put the w 14 by w naught value into this equation. So, find wf by w naught, 1 minus

0.693 into 6 per cent full tab full tab field. So, multiplied by 1.06 this is 0.325. So, this is a w f by w naught.

So, please check the all the calculation part and make it correct if there is any mistakes.

Thank you.